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[Title of the Invention] Liquid crystal display apparatus and manufacturing method thereof

[Abstract]

[Purpose] To provide a liquid crystal display apparatus with higher brightness and excellent display quality.

[Configuration] The simplification of the manufacturing process as well as the improvement in the aperture ratio of the pixel portion may be achieved because an insulating film 25 and the through holes 17, 21 therein etc. may be formed in sizes with a higher precision without the use of a photolithography process by making the insulating film through anodization of the upper layer portion of a light shielding film 23. Furthermore, since the insulating film formed through the anodization method have an extremely small number of pinholes, it is possible to reduce the risk of having electrical contact between a pixel electrode 27 to be formed on an upper layer

of the insulating film 25 and the shading film 23 formed on the lower layer of the insulating film.

[Claims]

[Claim 1] A liquid crystal display apparatus comprising;

a switching element array substrate including;

a plurality of scanning line wirings and signal wirings on a substrate;

a switching element connected to each of said scanning line wirings and each of said signal wirings;

a pixel electrode connected to said switching element; and

a light shielding film for shielding light incident on said switching element, which is disposed so as to be kept away from said pixel electrode;

a counter substrate having a counter electrode disposed thereon, which is provided so as to face said switching element array substrate with a gap therebetween; and

a liquid crystal composition which is sealed between said switching element array substrate and said counter substrate; wherein

said light shielding film is made of a metal material, and further comprising an insulating film formed by anodizing a top layer of said light shielding film.

[Claim 2] A manufacturing method of a liquid crystal

display apparatus comprising the steps of;

providing a plurality of gate line wirings, a plurality of signal line wirings, a switching element connected to each of said gate line wirings and each of said signal line wirings, and a pixel electrode connected to said switching element on a substrate;

providing a light shielding film so as to keep away from said pixel electrode, and to shield light incident on said switching element;

providing an insulating film over said light shielding film thereby forming a switching element array substrate;

combining said switching element array substrate with a counter electrode; and

introducing a liquid crystal composition therebetween; wherein

said light shielding film is formed by depositing a metal material, and said insulating film is formed through anodization of a top layer of said light shielding film.

[Detailed Description of the Invention]

[0001]

[Industrial Field of Application]

The present invention relates to a liquid crystal display apparatus having a light shielding film and manufacturing method thereof.

[0002]

[Background Art]

An active matrix liquid crystal display apparatus having a switching transistor for each of its display pixels is well known as suitable for improving display quality and driving speed of a liquid crystal display apparatus. As for the switching transistors, thin film transistors (TFT) using amorphous silicon (hereinafter referred to as a-Si), or polycrystalline silicon (hereinafter referred to as poly-Si) are typically used.

[0003]

The TFT by a-Si is suitable for large-screen liquid crystal display apparatus such as a wall-hanging type display or an OA display since it can be formed over a large area of an inexpensive glass substrate.

[0004]

On the other hand, the TFT by poly-Si, which has sufficient functionality as a switching element to drive a pixel of the liquid crystal display element even though the TFT size is small because of its relatively large carrier mobility which is several tens to $200cm^2/Vs$, is suitable for liquid crystal display apparatus required to have a small size and high definition such as a projection TV or a view finder of a video camera, since it allows to form peripheral driving circuitry integrally on the same substrate to minimize the overall size of the apparatus.

[0005]

Fig. 3(a) shows a plan view of a display pixel portion on the side of TFT substrate of prior art liquid crystal display apparatus using TFTs made of poly-Si, and Fig. 3(b) shows a cross sectional view of the same taken along the line A-B. A TFT 301 comprises a first poly-Si active layer 303, a gate insulating film 305, and a second poly-Si gate 307. Respective end portions of the gate 307 are a source 309 and a drain 311 of the TFT 301, and they are doped with P (phosphorous) which is an n-type dopant, thereby having a low resistivity. The drain 311 is connected to a signal line 315 made of Al with an inter-layer insulating film 313 interposed therebetween, and the gate 307 is integral with a gate line 317 made of second poly-Si. The source 309 is connected to a pixel electrode 316 made of ITO with the inter-layer insulating film 313 interposed therebetween. Further, the source 309 is connected to a storage capacitor 319. The storage capacitor 319 is a MOS capacitor, and its base portion 321 is made of the first poly-Si and is integral with the active layer 303 of the TFT301, and there is a storage capacitor line 325 made of the second poly-Si above it with an interposition of an insulating film 323 that is formed simultaneously with the gate insulating film 305.

[0006]

Fig. 4 is a partially-omitted perspective view of the TFT array substrate 401 having the above-mentioned display

pixels formed thereon, and a counter substrate 403. Formed over the counter substrate 403 are, a light shielding film 405 which is so-called black matrix (or black mask) and a counter electrode (not shown) constituted by a transparent electrode such as one made of ITO.

Typically, the light shielding film 405 as a black matrix is provided in such a shape as covers the gate lines 317, signal lines 315 and TFTs 301 that are formed over the TFT array substrate 401, and leaves apertures only for the portions corresponding to the pixel electrodes 316. The TFTs 301 may malfunction when light is irradiated thereon due to the increase in OFF current, regardless of whether its active layer is a-Si or poly-Si, so that the light shielding film is necessary to shield out such incident light that may cause malfunctioning of the TFTs. In the prior art liquid crystal display apparatus having such the configuration, high-precision alignment is necessary when assembling the TFT array substrate 401 and the counter substrate 403. In other words, when the gap portions, for example, between the pixel electrodes 316 and the signal wirings 315 are disposed within the apertures of the light shielding film 405 due to any misalignment introduced during the assembly of the TFT array substrate 401 and the counter substrate 403, the liquid crystal within those gaps will not be driven, so that in the case of a liquid crystal display element of normally white mode that uses TN-type liquid crystal, for example, light will always

go through those portions, thereby reducing the contrast ratio of the display pixels.

[0007]

In order to absorb any offset of the light shielding film 405 caused by the misalignment between the TFT array substrate and the counter substrate, the area of the apertures of the black matrix may be made smaller by reducing margins equivalent to the extent of the offset. However, this method will cause smaller aperture ratio of the area corresponding to the pixel display of the pixel electrode 316, causing the reduced brightness of the screen. On the other hand, it may be contemplated to improve the accuracy of the alignment itself, however, in reality, even though the alignment accuracy between the TFT array substrate 401 and the counter substrate 403 depends on the screen size, it is extremely difficult to make further improvement from the current possible error range, which is normally around ±2 μm for ones having diagonal sizes of about 5 inches, and around ±3 μm for ones having diagonal sizes of about 10 inches. Accordingly, in the prior art, overlaps of several micrometers or so are provided between the light shielding film and the pixel electrodes, which is roughly equivalent to the above alignment accuracy range.

[0008]

Furthermore, the TFT array substrate and the counter substrate have a difference in the thermal histories of

manufacturing processes. While a TFT array substrate using poly-Si is subject to a process of heating up to approximately 1000°C, and a TFT array substrate using a-Si is subject to a process of heating up to approximately 350°C, a counter substrate is subject to a process of heating only up to 200°C. Accordingly, the degrees of thermal expansion and extension are different in the TFT array substrate and in the counter substrate, thereby generating pitch shifts in the patterns over these two substrates. In order to absorb the offset, the margin must be made larger in the size of the apertures of the light shielding film, so that the aperture area of the light shielding film will further be reduced, which in turn, will further reduces the brightness of the screen.

[0009]

In order to solve the above problem, it is effective to form the light shielding film on the side of the TFT array substrate. Since the accuracy of the exposure mask alignment used in the manufacturing process of the TFT array may easily be brought down to 1 μm or less, the margin for absorbing the offset of the alignment between the counter substrate and the TFT array substrate will not be necessary thereby improving the aperture ratio.

[0010]

Fig. 5(a) is a plan view of the display pixel portion of the TFT array substrate on which the light shielding film

is formed, and Fig. 5(b) is a cross sectional view thereof taken along the ling A-B. The shaded section within Fig. 5(a) represents a portion covered by the light shielding film.

[0011]

A TFT 501 comprises an active layer 503 made of a first poly-Si provided over a substrate 500, an insulating film 505 and a gate 507 made of a second poly-Si having a low resistivity. The ends on the both sides of the gate 507 are a source 509 and a drain 511 of the TFT 501, to which P (phosphorous) as an n-type dopant is implanted to reduce the resistivity. The drain 511 is connected to a signal line 515 formed of Al with an inter-layer insulating film 513 provided therebetween, and the gate 507 is integral with a gate line 517 formed of the second poly-Si. Formed over the above laminate configuration is a second inter-layer insulating film 519, and a light shielding film 521 is formed and patterned on the second inter-layer insulating film 519. Furthermore, a third inter-layer insulating film 523 is formed over the light shielding film 521, and further thereon, a pixel electrode 525 made of ITO is formed and patterned. This pixel electrode 525 is connected to the source 509 of the TFT 501 through the first inter-layer insulating film 513, the second inter-layer insulating film 519, and the third inter-layer insulating film 523. To the light shielding film 521, a voltage is applied so that it retains a constant electric potential.

[0012]

[Problems the Invention Attempts to Solve]

However, with a TFT array substrate of the above-described configuration, when the pixel electrode 525 and the source 509 of the TFT 501 that is located below are connected together, it is necessary to provide an opening in the light shielding film 521 which constitutes the interlayer in order to avoid short circuiting between the layers caused by the provision of a through hole 527 for connecting these layers. This is to prevent the pixel electrode 525 and the light shielding film 521 having relatively high conductivities from coming into electrical contact. The light shielding film 521 must have the opening to avoid the through hole, however, the size of the opening has to make larger to accommodate the clearance that can absorb the positional shift that may be resulted from the manufacturing processes. More specifically, positional shift such as those caused from etching during photolithography processes of the respective layers such as the pixel electrode 525 has to be considered. For instance, when the size of each side of the through hole 527, which is provided on the first inter-layer insulating film 513 and the second inter-layer insulating film 519 in order to connect the pixel electrode 525 and the first poly-Si layer on which the source 509 of the TFT 501 is provided, is set to 5 μm x 5 μm, the opening of the light shielding film 521 must be equal to or larger than 10

μm x 10 μm considering mask displacement and etching accuracy.

[0013]

As a result, there is a problem in that the light leaks through that opening, thereby to degrade the function as the light shielding film to an insufficient level. Furthermore, since the area for an auxiliary capacitor will become smaller by the area of the opening, the value of the auxiliary capacitor that can possibly be achieved will become small to cause degradation of image quality.

[0014]

The present invention was made in order to solve these problems, and the purpose of which is to provide solutions to the problems such as the reduced aperture ratio of the light shielding film due to the required margins in order to absolve the positional shift occurred during manufacturing processes of the liquid crystal display apparatus, or the leakage of light caused by the need of expanding the opening area which is unnecessary for display, thereby providing a liquid crystal display apparatus with high brightness and good display quality.

[0015]

[Means to Solve the Problems]

A liquid crystal display apparatus according to the present invention comprises; a switching element array substrate including thereon, a plurality of scanning line wirings and a plurality of signal line wirings over the substrate,

a switching element connected to each of the scanning line wirings and each of the signal line wirings, a pixel electrode connected to the switching element, and a light shielding film to shield light incident on the switching element, which is disposed so as to be kept away from the pixel electrode; a counter substrate having a counter electrode, which is disposed so as to face to the switching element array with a gap therebetween; and a liquid crystal composition which is sealed between the switching element array substrate and the counter substrate; wherein the light shielding film is made of a metal material, and an insulating film formed through oxidization of an upper layer of the light shielding film is provided. Furthermore, a manufacturing method according to the present invention includes steps of; providing a plurality of gate line wirings, a plurality of signal line wirings, a switching element connected to each of the gate line wirings and each of the signal line wirings, and a pixel electrode connected to the switching element on a substrate; providing a light shielding film so as to shield light incident on at least the gate line wirings, the signal wirings or the switching element; providing an insulating film over the light shielding film thereby forming a switching element array substrate; combining the switching element substrate with a counter substrate; and introducing a liquid crystal composition therebetween; wherein the light shielding film is formed by depositing a metal material, and the insulating film

is formed through anodization of a top layer of the light shielding film. As for the material for the light shielding film, any metal with a high-melting-point such as Ta, Cr, Ti or W, or Al may be suitable.

[0016]

[Operation]

By providing an insulating film through anodization of the light shielding film, the manufacturing processes may be simplified and the aperture ratio of the pixel portions may be improved.

[0017]

Furthermore, the insulating film formed through anodization has an extremely small number of pin holes, so that any risk of inducing an electrical contact between the pixel electrode formed over this insulating film and the light shielding film formed under the insulating film may be reduced.

[0018]

In addition, since the TFT array substrate may be fabricated without expanding the opening for the through hole within the light shielding film, the problem in which the auxiliary capacitor had to be smaller due to the opening, and the degradation of the screen brightness due to the minimized aperture ratio of the display pixel electrode, may be resolved.

[0019]

[Embodiment]

An exemplary liquid crystal display apparatus according to the present invention will now be explained in conjunction with the drawings.

(Embodiment 1)

Fig. 1 is a cross sectional view of a portion of an exemplary liquid crystal display apparatus according to the first embodiment of the present invention. For the purpose of simplification, especially the TFT array substrate will be mainly explained.

[0020]

The display pixel portion of the liquid crystal display apparatus according to the first embodiment is configured as follows. Over a quartz substrate 1, a TFT element 12 is formed, which mainly comprises an active layer 3 made of a first poly-Si, a gate insulating film 5, a gate 7 made of a second poly-Si film having a low resistivity, and a source 9 and a drain 11 provided respectively on the right and left ends of the active layer 3 under the gate 7. A first inter-layer insulating film 13 made of SiO_2 is formed so as to cover the foregoing, and a through hole 15 is provided within the drain 11 portion in order to obtain an electrical contact from the outside of the first inter-layer insulating film 13 made of SiO_2. A signal line 17 made of Al is connected to the drain 11 via the through hole 15. A second inter-layer insulating film 19 is formed so as to cover the first inter-layer insulating film 13 and

the signal line 17, and a through hole 21 that reaches the end of the active layer 3 on the side of the source 9 is formed through the gate insulating film 5, the first inter-layer insulating film 13 and the second inter-layer insulating film 19. Furthermore, a light shielding film 23 made of a Ta film in a shape that allows to keep away from the pixel portions and shield the TFT element 12 from light, is formed as a so-called black matrix over the second inter-layer insulating film 19. On the outer surface (principal surface) of the light shielding film 23, a third inter-layer insulating film 25 is formed through oxidization of the surface of the light shielding film 23 itself.

[0021]

A pixel electrode 27 made of ITO is formed as an upper layer of the third inter-layer insulating film 25. This pixel electrode 27 is connected to the active layer 3 via the through hole 21, and to the source 9.

[0022]

A manufacturing method of the liquid crystal display apparatus according to the present embodiment will now be explained mainly on the pixel portion.

[0023]

Over a quartz substrate 1, a TFT element 12 mainly comprising an active layer 3 made of a first poly-Si, a gate insulating film 5, a gate 7 made of a second poly-Si film having a low resistivity, and a source 9 and drain 11 provided on the

right and left ends of the active layer 3 under the gate 7, is formed.

[0024]

The first poly-Si and the second poly-Si are formed through a low pressure CVD method, and the gate insulating film 5 is formed through a thermal oxidation method.

[0025]

The gate 7 is formed by etching the second poly-Si film. That is, it is integrally formed with the gate line (not shown) from a same film. The light and left portions of the active layer 3 under the gate 7 are the source 9 and drain 11 of the TFT element 12, and are processed through ion implantation of P (phosphorous) which is an n-type dopant to be formed as regions of a low resistivity.

[0026]

Next, a first inter-layer insulating film 13 made of SiO_2 is formed through a low pressure CVD method, and a through hole 15 is opened in the section of the drain 11 for gaining an electrical connection from the outside of the first inter-layer insulating film 13. An Al film is then formed by sputtering and patterned by etching in any desired shape to form a signal line 17. This signal line 17 is connected to the drain 11 via the aforementioned through hole 15.

[0027]

Next, through a normal pressure CVD method, a second

insulating film 19 is formed, and a through hole 21 that reaches the end on the side of the source 9 of the active layer 3.

[0028]

Thereafter, a Ta film is formed as a light shielding film 23 through sputtering, and it is patterned to form a black matrix having a predetermined shape.

[0029]

A voltage is applied to the light shielding film 23 as an anode, which is made of the Ta film in a predetermined shape, to anodize the outer surface (principal surface side) of the light shielding film 23 to form a third inter-layer insulating film 25. In the present embodiment, the light shielding film 23 has a continuous unitary shape with an opening at a portion corresponding to each of the pixels, so that a power source for the anodization was connected to one end thereof, and the anodization was performed within a citrate solution. The applied voltage and duration of the anodization were 100V and 60 minutes, and the thickness of the oxide film formed in this case was 1700Å. The opening for the through hole of the light shielding film 23 has expanded by approximately 1000 Å, since the anodization diffuses also into the Ta film.

[0030]

Thereafter, a pixel electrode 27 is formed by forming an ITO film through sputtering and patterning it. At this point, the pixel electrode 27 is connected to the active layer 3 via

the through hole 21, and then to the source 9.

[0031]

In the present embodiment, the size of the through hole provided on the first insulating film 13 and the second insulating film 19 was set to 5 μm x 5 μm, and the opening of the through hole for the light shielding film 23 was set to 7 μm x 7 μm by widening the sides of the aforementioned 5 μm x 5 μm by 1 μm each. In this case, it was possible to make contact between the pixel electrode 27 and the source 9 of the TFT element 12 without having the pixel electrode 27 to come into electrical contact with the light shielding film 23. The opening for the through hole of the light shielding film 23 would expand by approximately 1000 Å since the anodization diffuses into the Ta film as mentioned above, but there were only insignificant effects on the aperture ratio of the display pixel and the value of the auxiliary capacitor, so that the insulating film and the light shielding film may be formed with a good precision.

[0032]

(Embodiment 2)

The above first embodiment was the case of an active matrix-type liquid crystal display apparatus in which the group of the gate line, signal line and switching transistor, the light shielding film and a pixel electrode are laminated together in this order with the interpositions of the respective

insulating films, however, embodiments of the present invention are not limited to the above configuration.

[0033]

Fig. 2 is a cross-sectional view of an active matrix-type liquid crystal display apparatus according to the second embodiment, showing the configuration of the pixel portion.

[0034]

The liquid crystal display apparatus according to the second embodiment is a liquid crystal display apparatus in which a light shielding film 203 made of Ta is formed on a quartz substrate 201, and the light shielding film 203; a group of a gate wiring (not shown), a signal wiring 205 and a TFT element 207; and a pixel electrode 206; in this order, are laminated together with insulators 209, 229 interposed between the respective layers.

[0035]

At the upper layer portion of the light shielding film 203, a 2000Å thick insulating film 213 is formed through anodization of the Ta. Thereon, an SiO_2 film 215 is formed by a normal pressure CVD method. Further formed thereon is a TFT element 207 comprising an active layer 217 made of a first poly-Si, a gate insulating film 219, and a gate 221 made of a second poli-Si having a low resistivity. The respective ends of the active layer 217 under the gate 221 are a source 223 and drain 225 of the TFT element 207, and P (phosphorous) which is an

n-type dopant is implanted thereto to lower the resistivity. Further thereon, an SiO_2 film is formed as an inter-layer insulating film 209, and a signal line 205 made of Al is formed over the portion of the drain 225, which is connected to the drain 225 via a through hole 227. Thereon, a second insulating film 229 is formed. A pixel electrode 206 made of ITO is further formed, and is connected to the source 223 via the through hole 231.

[0036]

In the liquid crystal display apparatus of the second embodiment like this, any defect by having the light shielding film 203 and any other layer made of a conductor to come into electrical contact due to positional shift (pattern shift) may be avoided, however, it is still possible to have the light shielding film 203 to come into electrical contact with any other conductor due to pin holes. However, in the present invention, since the anodized film which has an extremely small number of pinholes is used, the occurrence of any defects in the film, such as the pinhole defects, may be suppressed.

[0037]

In the above embodiments, Ta is used as the light shielding film, however, it is not limited so. It is also possible to use a high-melting-point metal such as Cr, Ti or W, or it is further possible to use Al. In that case, the solution used during the anodization process is of course not limited to the

above-mentioned citrate, and any solution that is suitable to the metal may be used. As for a metal material of the light shielding film, any high-melting-point material, such as Cr, Ta, Ti or W, is typically used since it has low optical transmissivity, however, these high-melting-point materials are susceptible for oxidation, and when the formation of an SiO_2 film is attempted over the surface of the metal film via a low pressure CVD method or a normal pressure CVD method, the metal itself may quickly be oxidized to exhibit transparency within the visible light range, thereby becoming not functional as a light shielding film. These high-melting-point materials will be oxidized when 10ppm of oxygen is present at or above 400°C. Accordingly, when the formation of an insulating film over these high-melting-point materials is attempted, a plasma CVD method that allows the formation of a film under a low temperature must be chosen, however, the film obtained through a plasma CVD method has a low film quality since, as known, it will contain a large number of particles as well as a large number of pinholes. However, according to the present invention, it is possible to form an SiO_2 film over an anodized light shielding film through a low pressure CVD method or a normal pressure CVD method, or otherwise, a poly-Si film which serves as the active layer of the TFT element, may directly be formed without the formation of the SiO_2 film.

[0038]

Furthermore, with the liquid crystal display apparatus having a configuration of the above explained second embodiment, it is not necessarily impossible to omit or substitute the SiO_2 film 215. The SiO_2 film 215 is provided so as to thicken the inter-layer insulating film as a double-layer structure between the light shielding film 203 and the TFT 207. With this regard, the insulating film 213 may serve as the inter-layer insulating film as a single-layer structure when it is formed to have a relatively large thickness.

[0039]

Furthermore, in the above embodiment, the light shielding film has been explained to have a single, unitary shape even though it includes apertures, however, the pattern of the light shielding film is not limited to this configuration. For example, the technique of the present invention may be applied to a light shielding film that is divided into portions for respective pixels. In this case however, each of the divided light shielding films for each of the pixels must be connected by some sort of bridge patterns before the voltage can be applied to one end, but the anodization can be performed in substantially the same manner as the above embodiment.

[0040]

In addition, in the explanation of the first and second embodiments, an n-channel poly-Si TFT has been used, however, it is also effective when p-channel poly-Si TFT is used as a

switching transistor for each pixel. Furthermore, the switching transistor for each pixel is not limited to the poly-Si TFT, but a staggered-type a-Si TFT may also be used.

[0041]

[Effect of the Invention]

As clear from the above explanation, according to the present invention, problems such as the reduction of aperture ratio of the light shielding film due to the size margins needed for absorbing the positional shift occurred during manufacturing of the liquid crystal display apparatus, the leak of light due to expanded area of the openings that are unnecessary for display, may be solved, thereby providing a liquid crystal display apparatus with a high brightness and good display quality. Furthermore, the manufacturing method of such a liquid crystal display apparatus, especially the processes for the light shielding film and insulating film, may be simplified.

[Brief Description of Figures]

[Fig. 1] A plan view showing the structure of a display pixel portion of a liquid crystal display apparatus according to the first embodiment of the present invention.

[Fig. 2] A plan view showing the structure of a display pixel portion of a liquid crystal display apparatus according to the second embodiment of the present invention.

[Fig. 3] A plan view showing the structure of a display pixel portion of a prior art liquid crystal display apparatus.

[Fig. 4] A partially omitted perspective view showing a TFT array substrate and counter substrate of a liquid crystal display apparatus.

[Fig. 5] A view of a display pixel portion of a prior art liquid crystal display apparatus in which a light shielding film is formed on the side of TFT array substrate.

[Description of Reference Numerals]

1: quartz substrate, 3: active layer, 5: gate insulating film, 7: gate, 9: source, 11: drain, 12: TFT element, 13: first inter-layer insulating film, 15, 21: through holes, 17: signal line, 19: second inter-layer insulating film, 23: light shielding film, 25: third inter-layer insulating film, 27: pixel electrode

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[Amendment 1]

[Subject Document] Specification

[Subject Item] Title of Invention

[Method of Amendment] Modification

[Content of Amendment]

[Title of Invention] Thin film transistor, liquid crystal display apparatus and manufacturing method of liquid display apparatus

[Amendment 2]

[Subject Document] Specification

[Subject Item] Claims

[Method of Amendment] Modification

[Content of Amendment]

[Claims]

[Claim 1] A liquid crystal display apparatus comprising;

a switching element array substrate including;

a plurality of scanning line wirings and a plurality of signal wirings on a substrate;

a switching element connected to each of said scanning line wirings and each of said signal wirings;

a pixel electrode connected to said switching element; and

a light shielding film for shielding light incident on said switching element;

a counter substrate provided so as to face said switching element array substrate with a gap therebetween; and

a liquid crystal composition which is sealed between said switching element array substrate and said counter substrate; wherein

said light shielding film is made of a metal material, and further comprising an insulating film formed by anodizing a surface of said light shielding film.

[Claim 2] A manufacturing method of a liquid crystal display apparatus comprising the steps of;

providing a plurality of scanning line wirings, a plurality of signal line wirings, a switching element connected

to each of said scanning line wirings and each of said signal line wirings, and a pixel electrode connected to said switching element on a substrate;

providing a light shielding film made of a metal material for shielding light incident on said switching element;

providing an insulating film over said light shielding film thereby forming a switching element array substrate;

combining said switching element array substrate with a counter substrate; and

introducing a liquid crystal composition therebetween; wherein

said manufacturing method includes a step of forming said insulating film by oxidizing a surface of said light shielding film through anodization.

[Claim 3] A thin film transistor comprising an active layer having a channel, a source and a drain, a gate electrode formed correspondingly to said channel, a gate insulating film formed between said active layer and said gate electrode, and a light shielding film for shielding light incident on at least said channel, all of the foregoing formed on a single substrate, wherein said light shielding film is made of a metal material, and said thin film transistor has an insulating film formed through oxidization of said metal material at the surface of said light shielding film.

[Claim 4] A thin film transistor as claimed in claim

3 wherein said substrate has translucency, and said light shielding film and said insulating film are formed over said substrate, and thereon, said active layer, said gate insulating film and said gate electrode are formed in this order.

[Claim 5] A thin film transistor as claimed in claim 4 wherein said active layer is mainly made of polycrystalline silicon.

[Claim 6] A thin film transistor as claimed in claim 3 wherein said insulating film and other additional insulating film are formed between said light shielding film and said active layer.

[Amendment 3]

[Subject Document] Specification

[Subject Item] [0015]

[Method of Amendment] Modification

[Content of Amendment]

[0015]

[Means to Solve the Problems]

A liquid crystal display apparatus according to the present invention comprises; a switching element array substrate including thereon, a plurality of scanning line wirings and a plurality of signal line wirings over the substrate, a switching element connected to each of the scanning line wirings and each of the signal line wirings, a pixel electrode

connected to the switching element, and a light shielding film to shield light incident on the switching element; a counter substrate which is disposed so as to face to the switching element array substrate with a gap therebetween; and a liquid crystal composition which is sealed between the switching element array substrate and the counter substrate; wherein the light shielding film is made of a metal material, and an insulating film formed through oxidization of a surface of the light shielding film is provided. Furthermore, a manufacturing method according to the present invention includes steps of; providing a plurality of scanning line wirings, a plurality of signal line wirings, a switching element connected to each of the scanning line wirings and each of the signal line wirings, and a pixel electrode connected to the switching element on a substrate; providing a light shielding film made of a metal material for shielding light incident on the switching element; providing an insulating film over the light shielding film thereby forming a switching element array substrate; combining the switching element substrate with a counter substrate; and introducing a liquid crystal composition therebetween; wherein the insulating film is formed through oxidization of a surface of the light shielding film by anodization. Furthermore, a thin film transistor according to the present invention comprises an active layer having a channel, a source and a drain, a gate electrode formed correspondingly to the channel, a gate

insulating film formed between the active layer and the gate electrode, and a light shielding film for shielding light incident at least on the channel, all of the foregoing formed on a single substrate, wherein the light shielding film is made of a metal material, and the thin film transistor has an insulating film formed through oxidization of the metal material at a surface of the light shielding film. In the thin film transistor of the present invention, the substrate has translucency, and over this substrate, the light shielding film and the insulating film are formed, and thereon, the active layer, the gate insulating film, and the gate electrode are formed in this order. The active layer is mainly composed of polycrystalline silicon. Further, the insulating film and other additional insulating film are formed between the light shielding film and the active layer. As for the material for the light shielding film, any metal with a high-melting-point such as Ta, Cr, Ti or W, or Al may be suitable.